Teoría de la Educación
Educación y Cultura en la
Sociedad de la Información
UNIVERSIDAD DE SALAMANCA
TESI, 13(1), 2012, pp. 317-333

ANÁLISIS DEL EFECTO MODERADOR DE LA EDAD EN LA ACEPTACIÓN DE SISTEMAS E-LEARNING LMS

Resumen: El presente estudio analiza las intenciones de los usuarios acerca del uso de sistemas de tele-enseñanza LMS (*Learning Management Systems*), basándose en un modelo que integra el Modelo de Aceptación Tecnológica (TAM, Technology Acceptance Model), la Teoría del Comportamiento Percibido (TPB, *Theory of Planned Behavior*) y la Teoría Unificada de la Aceptación y Uso de la Tecnología (UTAUT, *Unified Theory of Acceptance and Use of Technology*), tomando la edad como variable moderadora.

Así, este artículo estudia la influencia de la intención conductual, la actitud hacia el uso, la facilidad de uso percibida, la utilidad percibida, la norma subjetiva y la influencia social en la intención de utilizar sistemas e-learning LMS. Como antecedentes de estos factores de influencia se plantean las características del sistema y del usuario.

El resultado de la revisión teórica es un modelo unificado que ha sido validado con datos recogidos de 94 estudiantes a través de un cuestionario en línea. Estos datos han sido analizados utilizando la técnica de mínimos cuadrados parciales, y los principales resultados confirman la relevancia predictiva del modelo para usuarios de entre 26 y 35 años y de entre 36 y 45 años.

Palabras clave: LMS; aprendizaje; e-learning; b-learning; TAM; TAM2; UTAUT; modelos de aceptación tecnológica; intención conductual; características del sistema; características del usuario; PLS.

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AN ANALYSIS OF THE MODERATING EFFECTS OF AGE IN THE ACCEPTANCE OF LEARNING MANAGEMENT SYSTEMS

Abstract: This study analyses students' intentions to use e-learning management systems based on an inventory which integrates the Technology Adoption Model (TAM), the Theory of Planned Behavior (TPB) and the Unified Theory of Acceptance and Use of Technology (UTAUT), with the difference of age as moderating variable. In particular, the most relevant learning management systems (LMS) adoption models have been reviewed from literature.

Thus, this paper studies the influence of behavioral intention, attitude toward use, perceived usefulness, perceived ease of use, subjective norms and social influence in the intention to use e-learning management systems. User and system characteristics have been proposed as antecedents of the former factors.

The result of this review is a unified model which has been validated with data collected from 94 students through a web questionnaire, and the results from this data have been analysed using the partial least squares (PLS) method. The analysis has demonstrated the predictive relevance and the validation of the model for users between 26 to 35 years old and 36 to 45 years old.

Keywords: LMS; learning; e-learning; b-learning; TAM; TAM2; UTAUT; technology acceptance models; behavioral intention; system characteristics; user characteristics; PLS.

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AN ANALYSIS OF THE MODERATING EFFECTS OF AGE IN THE ACCEPTANCE OF LEARNING MANAGEMENT SYSTEMS

Fecha de recepción: 07/11/2011; fecha de aceptación: 10011/2012; fecha de publicación: 05/03/2012

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1.- INTRODUCTION

In the past years the use and implementation of LMS has been growing rapidly, both in the industrial and academic environment. The use of TEL (Technology Enhanced Learning) is a fundamental concept for the current learning processes because technology allows expanding the learning scope. In the last 40 years, the various technologies supporting these learning processes have received different names, although the more accepted term nowadays is e-learning, which can be defined as "the use of the new multimedia technology and Internet, to improve the learning quality, supporting the access to resources and services, as well as the interchange and the remote collaboration" (Communication from the Commission to the Council and the European Parliament, 2001).

This study covers the most influent factors in the users' intention to use LMS systems, based on a review of technology adoption models, with special focus on those applied to LMS systems, as well as an analysis of LMS implementation case studies, and proposes a study framework based on a unified model for LMS adoption.

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2.- THEORETICAL BACKGROUND

2.1.- LMS adoption models

In order to examine the intention to use LMS, there is a wide range of theoretical models for characterizing technological acceptance, being the most relevant TAM (Technology Acceptance Model; Davis, 1989), UTAUT (Unified Theory of Acceptance and Use of Technology; Venkatesh, *et al*., 2003), TRA (Theory of Reasoned Action; Fishbein & Ajzen, 1975), TAM2 (Venkatesh & Davis, 2000), TPB (Theory of Planned Behaviour; Ajzen, 1991), MM (Motivational Model) (Vallerand & Ratelle, 2002), PC MPCU (Model of PC Utilization; Thompson, *et al*., 1991), IDT (Innovation Diffusion Theory; Moore & Benbasat, 1991), and SCT (Social Cognitive Theory; Bandura, 1986).

According to Venkatesh *et al*. (2003), Fig. 1 shows the framework of the three basic concepts present in the majority of the aforementioned technological acceptance models. The main differences among the various models rely on the concept of an "individual's reactions to the use of information technology", since the definition of the variables which have influence on both intentions to use information technology and actual use of information technology, may be different depending on the definition and composition of that concept.

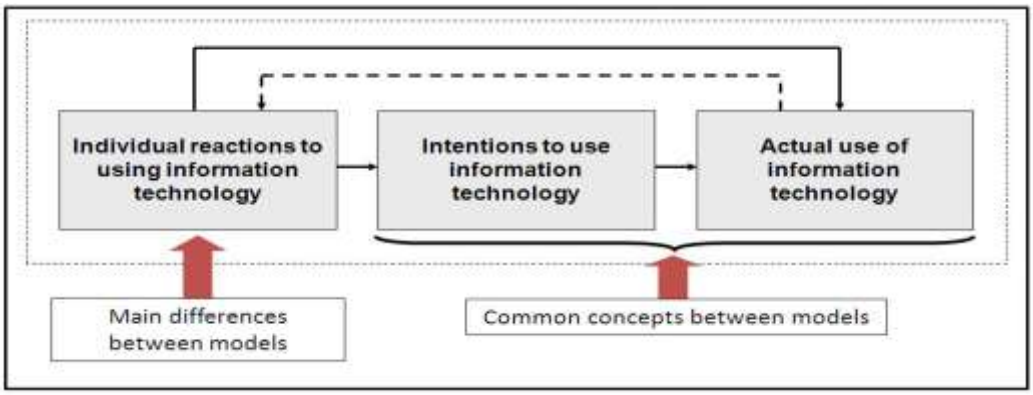

Figure 1. Technological Acceptance Models and Basic Concepts

Based upon the common constructs presented in these theories, and extracting other factors identified on LMS adoption focused studies (Moon & Kim, 2001; Saadé & Bahli, 2005; Thompson, *et al*., 1991), four types of constructs have been identified:

1. Actual use of LMS technologies.

2. Intention to use/attitude towards use. This is a predisposition against or towards a stimulus object (Fishbein & Ajzen, 1975); in this particular case, the the stimulus object would be the use of a LMS.

3. Antecedents of attitude towards use. The most relevant antecedents of attitude are those related to TAM (perceived ease of use and perceived usefulness) and TPB (normative and social factors, such as normative beliefs and subjective norm).

4. A group of different factors which have influence on the antecedents of attitude. These factors include self-efficacy, anxiety, system functionality, performance expectations, and quality of contents, and can be classified into two separate groups: those that can be considered user-related (i.e., self-efficacy, anxiety, performance expectations) and those which are system-related (i.e., functionality, contents).

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2.2.- LMS design and learning methodologies

Although e-learning LMS systems are supported over multiples pedagogical methodologies, there are currently not clear guidelines for analyzing, designing and implementing these tools, from a pedagogical point of view. In order to confront this problem, according to Kerkiri *et al*. (2009), there are already LMS implementations benefiting from the semantic web technologies and ontologies. Moreover, metadata-based models have been proposed for representing, detecting, and even automatically correct possible pitfalls in the schedule process of a learning design in e-learning environments (Camacho & R-Moreno, 2007). But, according to Chatti *et al.* (2007), e-learning solutions require a move away from one-size-fits-all content-centric models, and move towards a user-centric model that puts the learner/knowledge worker at the centre and gives him/her the control. This would mean a shift from e-learning to me-learning; a vision that will provide personalised learning experiences to every person everyday (Hodgins, 2005) and even an evolution from LMS to Personal Learning Environments (PLE). In this context, the perceptions of all the agents participating in the learning process towards using these systems become a critical issue which may determine the LMS or PLE implementation success or failure.

In addition, different variants of e-learning systems have been appearing, the most relevant is the b-learning (blended learning). According to Oliver & Trigwell (2005), the term 'blended learning' has gained considerable currency in recent years as a description of particular forms of teaching with technology. Whitelock & Jelfs (2003) propose the following three definitions:

1. The integrated combination of traditional learning with web-based online approaches;
2. The combination of media and tools employed in an e-learning environment;
3. The combination of a number of pedagogic approaches, irrespective of learning technology use.

Of these, the first is perhaps the most common interpretation; from that definition, it is obvious that e-learning must take into account not only learning agents' but also the specific characteristics of web-based learning systems –such as LMS–.

2.3.- Research Model and Hypotheses

In order to define the research model, the aforementioned technological acceptance models, as well as use cases related to e-learning system acceptance, have been reviewed and compared. The most relevant use cases analyzed correspond to Chiu and Wang (2008), Saadé and Bahli (2005), Ya-Ching (2008), Moon and Kim (2001) and Thompson, *et al*. (1991). Regarding b-learning systems, the main use cases considered for this study correspond to Diamantini and Pieri (2008), Poce (2008) and Kerres and De Witt (2003). According to theoretical and practical analysis from these studies, four main latent variables –perceived usefulness, perceived ease of use, subjective norms and social influence– have been identified as antecedents of attitude toward behavior and behavioral intention, which in turn are, according to acceptance theories, the main predictors of actual use. Following the discussion from section 2.2., it is expected that system and user specific factors may have an influence on these antecedents. Therefore, relationships between this variables have been established considering the use cases reviewed, and finally the research model and hypotheses were formulated. Fig. 2 illustrates the research model, hypotheses and relations between constructs.

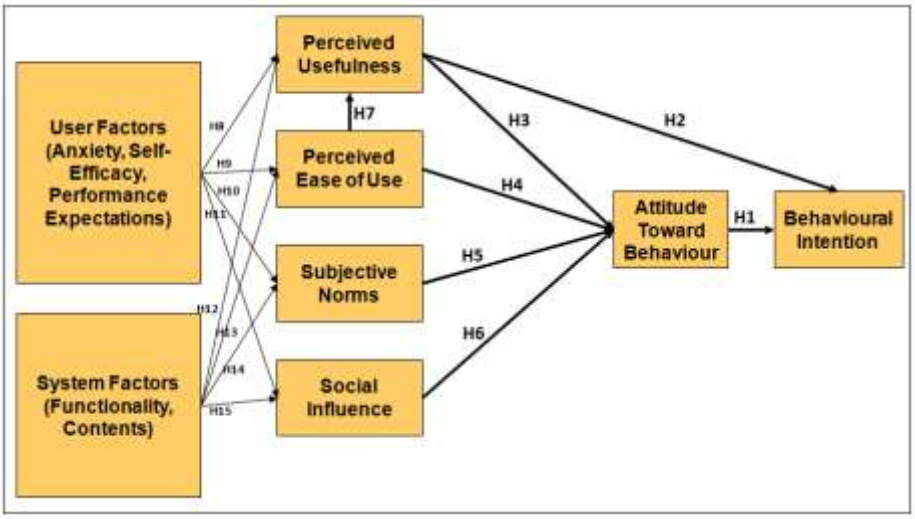

Figure 2. Research Model and Hypotheses

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The following hypotheses were formulated:

- **H1, H2**: Behavioral intention is positively influenced by attitude towards behavior and the perceived usefulness.
- **H3, H4, H5, H6**: Attitude towards behavior is positively affected by perceived usefulness, perceived ease of use, subjective norms and social influence.
- **H7**: Perceived usefulness is positively influenced by perceived ease of use.
- **H8, H9, H10, H11**: User related factors have a positive influence on perceived usefulness, perceived ease of use, subjective norms and social influence.
- **H12, H13 H14, H15**: System related factors have a positive influence on perceived usefulness, perceived ease of use, subjective norms and social influence.

3.- RESEARCH DESIGN AND METHODOLOGY

A survey from the research model was taken to 200 Spanish students, grouped by age (from 18 to 25 years, from 26 to 35 years, and from 36 to 45 years), who had previous experience with e-learning systems, from both the academic and working contexts. The survey included 41 items, measured using a seven-point Likert-type scale and ranging from "Strongly disagree" to "Strongly agree".

The survey data was gathered via LimeWire Survey web tool. The survey was anonymous and was sent to respondents by email with the link reference.

In order to perform the analysis of results, a soft-modelling SEM (Structured Equations Model) approach was used, with Partial Least Squares (PLS) as the chosen analysis technique, since PLS can provide both confirmatory analysis and model predictive ability assessment. According to Fornell and Bookstein (1982) and Barclay *et al.* (1995), PLS also presents relevant advantages, such as minimal sample size requirements, with different measurement scales and kind of variables. PLSGraph software was used for extraction and analysis of results.

4.- DATA ANALYSIS

A total of 94 complete surveys were received (for a 47 percent total answering rate). Data from this survey were exported from the web tool to Microsoft Excel, and then converted to PLS-Graph readable files. The sample size was adequate for analysis according to the criteria from Barclay *et al*. (1995), except for the group of students ranging from 18 to 25 years old, with a sample size of 20.

Next, measurement model and structural model validity were performed; for measurement model validity assessment, factor analysis, convergent validity and discriminant validity were tested (Table 1 displays the results from the factor analysis and convergent validity assessment).

The factor loadings for each construct and item are significantly greater than the acceptable limit of 0.5, and most of them are greater than the optimal limit of 0.707. Composite reliability values are significantly greater than the optimal limit of 0.7; with most of them higher than 0.9. On the other hand, the AVE (Average Variance Extracted) values are equal or greater than the minimal limit of 0.5. AVE values for the construct "User Factors" fell slightly below the limit of 0.5. Indicators below the cut-off range were discarded for the analysis.

Then, a discriminant validity analysis was performed (results are shown in Table 2). In this analysis, the squared root AVEs are greater than the correlations between constructs –except for the group of students ranging from 26 to 35 years old, within the construct "User Factors"–. Yet, another discriminant validity analysis was done, taking into account the correlations between item weights and constructs. For most of the indicators, the item loadings inside the construct are greater than the loading with the rest of the items measuring other constructs.

Finally, structural model validity was studied. This analysis includes the construct variance explained (R^2), the predictive relevance (Q^2), and the values of the significant structural paths. Table 3 illustrates R^2 and Q^2 analysis.

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As shown in Table 3, the construct variance explained (R^2), for the ranges between 26 to 35 years old and 36 to 45 years old indicate a good explanation of the model –more than 50 percent of the variance explained in the former case and more than 75 percent in the latter–. For the range between 18 to 25 years old, values were lower than 50 percent –mainly for behavioural intention–.

To observe the model's predictive ability analysis, a Stone-Geisser's or Q^2 test was performed. The results for the different relations in the ranges between 26 to 35 years old and 36 to 45 years old indicate predictive relevance (all values were greater than zero). On the other hand, values for the group of students between 18 and 25 years showed no predictive relevance, and also a very low value of variance explained for the total model of 12,4 percent.

		18 to 25 years old			26 to 35 years old			36 to 45 years old		
Construct	Item	Factorial Loading	Composite Reliability	AVE	Factorial Loading	Composite Reliability	AVE	Factorial Loading	Composite Reliability	AVE
User Factors	CU3	0,725	0,848	0,488	0,421	0,831	0,474	0,816	0,923	0,669
	CU4	0,729			0,444			0,870		
	CU5	0,511			0,480			0,729		
	CU6	0,881			0,869			0,820		
	CU7	0,666			0,862			0,885		
	CU8	0,625			0,861			0,777		
System Factors	CS1	0,283	0,869	0,593	0,790	0,939	0,754	0,871	0,951	0,795
	CS2	0,831			0,848			0,891		
	CS3	0,881			0,883			0,932		
	CS4	0,862			0,909			0,882		
	CS5	0,821			0,906			0,882		
Perceived Usefulness	UP1	0,879	0,868	0,622	0,836	0,934	0,779	0,904	0,960	0,857
	UP2	0,732			0,855			0,892		
	UP3	0,764			0,887			0,964		
	UP4	0,774			0,949			0,941		
Perceived Ease of Use	FU1	0,859	0,922	0,749	0,887	0,941	0,801	0,940	0,939	0,794
	FU2	0,792			0,911			0,835		
	FU3	0,958			0,907			0,898		
	FU4	0,847			0,874			0,890		
Subjective Norms	NS1	0,901	0,913	0,840	0,918	0,926	0,863	0,962	0,980	0,961
	NS2	0,932			0,940			0,979		
Social Influence	IS2	0,870	0,908	0,832	0,898	0,885	0,794	0,971	0,958	0,919
	IS3	0,953			0,884			0,946		
Attitude Toward Behaviour	AU1	0,799	0,874	0,635	0,849	0,907	0,711	0,901	0,941	0,799
	AU2	0,855			0,909			0,889		
	AU3	0,813			0,765			0,914		
	AU4	0,712			0,844			0,871		
Behavioural Intention	IU1	0,874	0,915	0,782	0,953	0,958	0,883	0,946	0,964	0,898
	IU2	0,867			0,924			0,934		
	IU3	0,912			0,941			0,964		

Table 1. Measurement model validity assessment (factor analysis and convergent validity)

18 to 25 years old								
	UF	SF	PU	PEU	SN	SI	ATB	BI
UF	**0,699**							
SF	0,687	**0,770**						
PU	0,700	0,450	**0,789**					
PEU	0,637	0,532	0,590	**0,865**				
SN	0,506	0,333	0,322	0,333	**0,917**			
SI	0,602	0,564	0,304	0,455	0,438	**0,912**		
ATB	0,651	0,526	0,691	0,561	0,295	0,463	**0,797**	
BI	0,424	0,388	0,164	0,144	0,424	0,388	0,338	**0,884**

26 to 35 years old								
	UF	SF	PU	PEU	SN	SI	ATB	BI
UF	**0,688**							
SF	0,630	**0,868**						
PU	0,675	0,742	**0,883**					
PEU	0,717	0,753	0,637	**0,895**				
SN	0,512	0,605	0,462	0,504	**0,929**			
SI	0,717	0,628	0,677	0,711	0,516	**0,891**		
ATB	0,775	0,758	0,806	0,764	0,497	0,735	**0,843**	
BI	0,567	0,453	0,522	0,616	0,247	0,580	0,709	**0,940**

36 to 45 years old								
	UF	SF	PU	PEU	SN	SI	ATB	BI
UF	**0,818**							
SF	0,684	**0,892**						
PU	0,597	0,207	**0,926**					
PEU	0,803	0,821	0,392	**0,891**				
SN	0,687	0,273	0,593	0,452	**0,980**			
SI	0,654	0,519	0,377	0,567	0,668	**0,959**		
ATB	0,727	0,515	0,832	0,661	0,637	0,556	**0,894**	
BI	0,661	0,412	0,816	0,586	0,619	0,670	0,848	**0,948**

Table 1. Measurement model validity assessment (discriminant validity)

	18 to 25 years old		26 to 35 years old		36 to 45 years old	
Construct	R^2	Q^2	R^2	Q^2	R^2	Q^2
Behavioural Intention	0,124	-0,424	0,510	0,377	0,759	0,617
Attitude Toward Behaviour	0,560	0,164	0,769	0,484	0,833	0,594
Perceived Usefulness	0,531	0,126	0,621	0,431	0,434	0,255
Perceived Ease of Use	0,423	0,136	0,664	0,491	0,784	0,581
Subjective Norms	0,256	-0,142	0,394	0,210	0,545	0,424
Social Influence	0,405	0,119	0,566	0,391	0,437	0,265

Table 2. Construct variance explained (R^2) and predictive relevance (Q^2)

Then, structural paths were analyzed (results are shown in Fig. 3). Although predictive relevance could not be assured for the group of students between 18 to 25 years old, behavioural intention would be influenced by attitude towards behaviour, which is influenced by perceived usefulness (strongly) and social influence. User factors would have a more notable influence on perceived usefulness than perceived ease of use, and social influence is determined by user factors (0.406) and, to a lesser extent, by system factors (0.285).

The analysis of results for students in the range between 26 to 35 years old indicates that behavioural intention is highly and positively predicted by attitude toward behaviour (0.824). Attitude toward behaviour is in turn influenced by perceived usefulness (0.468) and perceived ease of use (0.335). Finally, perceived usefulness and perceived ease of use are influenced by user factors (0.350 and 0.402), but a stronger influence of system factors (0.532 and 0.499) was observed.

For the range of 36-45 years old, behavioural intention was found to be predicted by attitude toward behaviour (0.551) and perceived usefulness (0.375). Attitude toward behaviour was also highly influenced by perceived usefulness (0.638), proving both direct and mediated effects of perceived usefulness, and perceived ease of use (0.340). Finally, perceived usefulness was found to be predicted only by user factors (0.824),while perceived ease of use was predicted by both user and system factors (0.455 and 0.510, respectively).

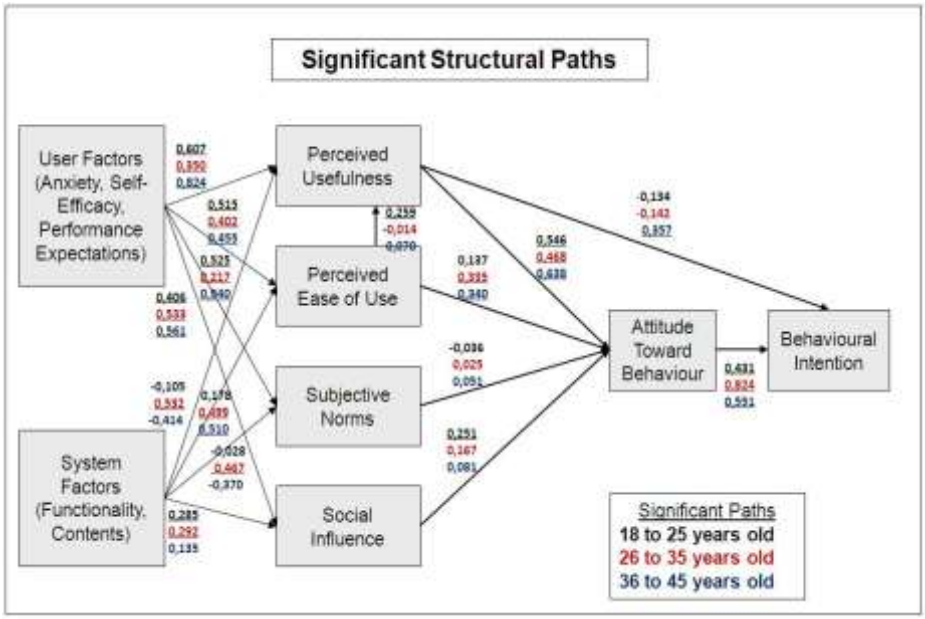

Figure 2. Structural paths (significant paths are underlined)

Group	H1	H2	H3	H4	H5	H6	H7	H8	H9	H10	H11	H12	H13	H14	H15
18-25															
26-35	X		X	X				X	X	X	X	X	X	X	X
36-45	X	X	X	X				X	X	X	X		X		

Table 4. Supported and unsupported hypotheses

In summary, the range between 26 to 35 years old supports the hypotheses: H1, H3, H4, H8, H9, H10, H11, H12, H13, H14, H15; and the range between 36 to 45 years old supports the hypotheses: H1, H2, H3, H4, H8, H9, H10, H11, H13.

5.- CONCLUSIONS

The analysis has confirmed the predictive relevance and the validation of the model for users between 26 to 35 years old and 36 to 45 years old, whereas no significant relations were extracted from the analysis of users between 18 and 25 years old, most probably due to the small data sample used for this segment of users. However, social influence outstands as a significant factor on attitude towards behaviour, whilst this relation is not confirmed on the other two groups. The main reasons behind this finding may be both the obligation to take courses under LMS environments, and/or the peer pressure when there has been a successful experience in the use of LMS.

The importance of perceived usefulness stands out as the most relevant factor impacting attitude towards behaviour; this result suggests the need to use of LMS only where the benefits related to LMS usage exceed those of traditional learning.

Also, the authors think that a more detailed study should be made about the construct "user factors", as it could be interesting to decompose it into three sub-constructs: anxiety, self-efficacy and performance expectations, so that influence of each one could be assessed.

Surprisingly, both subjective norms and social influence seemed to have weak or no influence on attitude towards behaviour. The explanation to this result may lay on the non coercive –i.e. voluntary– nature of courses taken by the students, perceived by the students more as an individual opportunity than a group obligation.

Another point of interest rises from the results on the relevance of system factors, which only seem to be relevant for the group between 26 to 35 years. In the authors' opinion, this result should be contrasted with another experiment; if this difference is confirmed,

reasons behind this finding should be studied in order to be able to make a better design of LMS systems taking into account the age profile of students.

Regarding to theoretical models, not all of them were used with equally distributed frequencies in the reviewed use cases related to e-learning system acceptance. The use of the TAM model is predominant, as it used in approximately the 70 percent of the use cases –some of them with adaptations including external factors, which have been considered in this study– and the UTAUT model is used in approximately the 12 percent of the use cases. However, the cause of this low use of the UTAUT model could have its origin in the novelty of the model, when compared to a more established one such as TAM; therefore, this difference was expected prior to the research. On the other hand, it is important to stress that TAM's predictive ability may be weaker when external variables are added, and this could be a disadvantage on this kind of analysis of e-learning systems where taking into consideration external factors is necessary. Consequently, this issue was taken into account for the design of the research model, including the external variables "user factors" and "system factors" in the unified model used for this study.

Regarding the design of e-learning systems (including b-learning solutions), it must be pointed out that these implementations should be supported over pedagogical methodologies, while some good practices would include enhancing traditional learning by integrating the use of current trends, such as semantic web technologies and ontologies, in the LMS.

Finally, it should also be noted that few use cases focusing on b-learning systems -blended-learning– systems could be found; it would be important to include more of these use cases in future studies, taking into account the current trends in the acceptance of this specific kind of e-learning systems.

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Para citar el presente artículo puede utilizar la siguiente referencia:

Dueñas-Rugnon , O. L., Iglesias-Pradas, S. y Agudo-Peregrina, A. F. (2012). Análisis del efecto moderador de la edad en la aceptación de sistemas e-learning lms. *Revista Teoría de la Educación: Educación y Cultura en la Sociedad de la Información*. *13*(1), 317-332 [Fecha de consulta: dd/mm/aaaa].
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